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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/611,931	07/03/2003	Panayotis C. Andricacos	YOR920020368US1	3968

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EXAMINER

CHU, CHRIS C

ART UNIT	PAPER NUMBER
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2815

DATE MAILED: 10/19/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/611,931

Applicant(s)

ANDRICACOS ET AL.

Examiner

Chris C. Chu

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 28 July 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1 - 42 is/are pending in the application.
- 4a) Of the above claim(s) 27 - 37 and 40 - 42 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1 - 26, 38 and 39 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>2/3/04</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Election/Restrictions

1. Applicant's election of Group I in the reply filed on July 28, 2004 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.03(a)).

Information Disclosure Statement

2. The listing of references in the specification is not a proper information disclosure statement. 37 CFR 1.98(b) requires a list of all patents, publications, or other information submitted for consideration by the Office, and MPEP § 609 A(1) states, "the list may not be incorporated into the specification but must be submitted in a separate paper." Therefore, unless the references have been cited by the examiner on form PTO-892, they have not been considered.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claim 13 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 13, line 2, “the dielectric material” lacks antecedent basis because there are more than one dielectric material in combined structure of claim 1 and 12.

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

6. Claims 1 – 6, 9 – 15, 19, 21 – 23, 38 and 39 are rejected under 35 U.S.C. 102(b) as being anticipated by Chung ‘607.

Regarding claims 1 and 38, Chung discloses in e.g., Figs.3 – 6 and column 7, lines 15 – 55 a method for fabricating a patterned copper structure which comprises

- providing a dielectric material (4) on a substrate (2; column 3, lines 4 – 5),
- providing at least one trench/via (at the trench that is pointed by the element 6) in the dielectric material;
- providing a liner (6) on the bottom and sidewalls of the at least one trench/via and on horizontal surfaces of the dielectric material in the vicinity of the at least one trench/via;

- depositing copper (Cu 8; column 7, lines 23 – 29) in the at least one trench/via on the liner; and
- selectively etching the copper (12 in Fig. 4 and column 7, lines 37 - 49) to recess the copper with respect to the top surfaces of the dielectric.

Regarding claim 2, according to applicants' specification on page 7, section 0040, the electropolishing is a part of an electroetching and Chung discloses in e.g., column 7, lines 45 – 47 an electropolishing to etch the Cu layer. Chung discloses electroetching.

Regarding claim 3, Chung discloses in e.g., Fig. 5 and column 7, lines 15 – 55 the etching comprising chemical etching (e.g., plasma etch, wet etch).

Regarding claim 4, Chung discloses in e.g., Fig. 5 and column 7, lines 15 – 55 the selective Cu etching being followed by blanket deposition (the deposition of the element 14 in Fig. 5) of one or more barrier or dielectric materials (Figs. 5 – 7 and column 7, lines 57 – 67).

Regarding claim 5, Chung discloses in e.g., Fig. 5, Fig. 6 and column 7, lines 15 – 55 said blanket deposition being followed by planarization for removing liner (6) from the horizontal surfaces of the dielectric (4 and see Fig. 6).

Regarding claim 6, Chung discloses in e.g., Fig. 6 and column 7, lines 15 – 55 the selective Cu etching being followed by the selective deposition (14) on the Cu of one or more materials by electrolytic plating (the electroplating process of the barrier layer 14 on column 7, lines 15 – 22 and lines 49 – 54).

Regarding claim 9, Chung discloses in e.g., Fig. 5 and column 7, lines 15 – 55 the selective Cu etching being followed by blanket deposition (the deposition of the element 14 in Fig. 5) of one or more metals or alloys (Figs. 5 – 7 and column 7, lines 57 – 67).

Regarding claim 10, Chung discloses in e.g., Fig. 5 and column 7, lines 15 – 22 said metals or alloys being Ta or TaN (column 7, lines 19 - 21).

Regarding claim 11, Chung discloses in e.g., Fig. 5, Fig. 6 and column 7, lines 15 – 55 said deposition being followed by planarization for removing layers (6 and 14) on the horizontal surfaces of the dielectric material (4 and see Fig. 6).

Regarding claim 12, Chung discloses in e.g., column 7, lines 60 – 67 said blanket deposition of a metal or alloy being followed by the blanket deposition of a dielectric material (16).

Regarding claim 13, since Chung discloses in e.g., column 8, lines 7 – 19 the substrate having series of layers on top of the substrate, Chung discloses said deposition being followed by planarization for removing layers (Cu layer and barrier layer) on horizontal surfaces of the dielectric material (16).

Regarding claims 14 and 22, since Chung discloses in e.g., column 8, lines 7 – 19 the substrate having series of layers on top of the substrate, Chung discloses said selective deposition by electrolytic plating (14) being followed by the blanket deposition of a metal or alloy (the metal layer or barrier layer that forms in any of the upper layer).

Regarding claims 15 and 23, since Chung discloses in e.g., column 8, lines 7 – 19 the substrate having series of layers on top of the substrate, Chung discloses planarization following said blanket deposition.

Regarding claims 19 and 39, Chung discloses in e.g., Figs.3 – 6 and column 7, lines 15 – 55 a method for fabricating a patterned copper structure which comprises

- providing a dielectric material (4) on a substrate (2; column 3, lines 4 – 5),

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- providing a liner (6) on the bottom and sidewalls of the at least one trench/via (at the trench that is pointed by the element 6) and on horizontal surfaces of the dielectric material in the vicinity of the at least one trench/via;
- depositing copper (Cu 8; column 7, lines 23 – 29) in the at least one trench/via on the liner for filling the at least one trench/via; and
- selectively electroplating a metal or alloy (14) on the copper (the electroplating process of the barrier layer 14 on column 7, lines 15 – 22 and lines 49 – 54).

Regarding claim 21, Chung discloses in e.g., Fig. 5, Fig. 6 and column 7, lines 15 – 55 planarizing after the electroplating for removing liner (6) from the horizontal surfaces of the dielectric (4 and see Fig. 6).

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all

obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. Claims 7, 8 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chung in view of Liu et al. '274.

Regarding claims 7 and 20, while Chung teaches the use of the material layer on the Cu, Chung does not appear to provide the material layer's specific composition. Liu et al. teaches in column 3, lines 48 – 52 using Co as a specific composition for a material layer (22) with TaN

layer on a Cu (18). It would have been obvious to one of ordinary skill in the art at the time when the invention was made to add the Co as the specific composition for the material layer with TaN layer on the Cu of Chung as taught by Liu et al. to avoid copper corrosion and oxidation of planarized final copper structure (column 3, line 67 – column 4, line 3).

Regarding claim 8, Chung discloses in e.g., Fig. 5, Fig. 6 and column 7, lines 15 – 55 said electrolytic plating being followed by planarization for removing liner (6) from the horizontal surfaces of the dielectric (4).

Allowable Subject Matter

9. Claims 16 – 18 and 24 – 26 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

(a) Claim 16 contains allowable subject matter because none of references of record teach or suggest, either singularly or in combination, at least the limitation of a removing said liner from horizontal surfaces on said dielectric followed by selectively seeding the copper and then plating a capping layer on the seeding by electroless plating.

(b) Since claims 17 and 18 are dependent claims of an objected claim (claim 16), these claims are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims (e.g., 16).

(c) Claims 24 – 26 contain allowable subject matter because none of references of record teach or suggest, either singularly or in combination, at least the limitation of a

metal or alloy being applied through a nozzle for a selective electroplating and the nozzle being circular with a diameter smaller than a diameter of a substrate for reducing the overall current during the electroplating and wherein the electroplating is carried out under substantially constant current conditions.

Conclusion

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Krishnan et al., Chen, Gupta et al., Yu et al., Zhao et al., Shue, Lee, Wong, Harada et al. and Avanzino et al. disclose a recessed copper plug in a dielectric layer.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Chris C. Chu whose telephone number is 571-272-1724. The examiner can normally be reached on 11:30 - 8:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on 517-272-1664. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.


Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>.

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Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Chris C. Chu
Examiner
Art Unit 2815

c.c.
Friday, October 15, 2004


GEORGE ECKERT
PRIMARY EXAMINER